Please replace the abstract with:

Abstract

The present invention is an improved electrode array for neuro-stimulation. The electrode array of the present invention is ideally suited for a visual prosthesis for the restoration of sight in patients with lost or degraded visual function. The electrode array of the present invention improves connectivity between a prosthesis and neurons.

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In the Claims:

Please delete claims 1 – 268, without prejudice.

Please add claims 269- 331 as follows:

269. An implantable electrode array comprising:
an electrode array body; and
a plurality of protuberances, each having a base end connected to said array body and a tip end, wherein said tip end is larger than said base end.

270. The implantable electrode array according to claim 269, wherein said protuberances are generally mushroom shaped.

271. An implantable visual prosthesis comprising:
an electrode array body;
insulation covering said electrode array body forming voids; and
a plurality of electrodes recessed within said voids.

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272. An implantable electrode array comprising:
an electrode array body, having a generally curved surface on at least one side;
insulation covering said electrode array body forming voids; and
a plurality of electrodes recessed within said voids.

273. An implantable electrode array comprising:
an electrode array body;
insulation covering said electrode array body forming voids; and
a plurality of electrodes recessed within said voids, and exposed in more than one dimension.

274. The implantable electrode array according to claim 273, wherein said plurality of electrodes are metal slugs attached to a substrate by conductive adhesive.

275. An implantable electrode array for retinal stimulation comprising:
an electrode array body;
a plurality of electrodes deposited on said electrode array body and positioned adjacent to a retina; and
insulation covering said plurality of electrodes whereby said plurality of electrodes forms capacitors with the retina.

276. The implantable electrode array according to claim 275, wherein said plurality of electrodes are metal, at least partially coated in ceramic.

277. The implantable electrode array according to claim 275, wherein said plurality of electrodes are formed from tantalum.

278. The implantable electrode array according to claim 275, wherein said plurality of electrodes are formed from titanium.

279. An implantable electrode array for neural stimulation comprising:
an electrode array body;
a plurality of capacitors supported by said array body; and
a plurality of electrodes supported by said capacitors.

280. The implantable electrode array according to claim 279, wherein said capacitors are discrete components.

281. An implantable device comprising:
an integrated circuit;
a plurality of capacitors supported by, and electrically coupled to, said integrated circuit; and
a plurality of electrodes electrically coupled to said plurality of capacitors.

282. An implantable electrode array for neural stimulation comprising:
an electrode array body; and
a plurality of pyrolytic carbon electrodes on said electrode array body.

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283. An eye-implantable retinal electrode array comprising:
an epiretinal electrode; and
a subretinal electrode.

284. The eye-implantable retinal electrode array according to claim 283, wherein said epiretinal electrode and said subretinal electrode are held in a prescribed relationship to each other by magnets.

285. The eye-implantable retinal electrode array according to claim 283, wherein said epiretinal electrode and said subretinal electrode are held in a prescribed relationship to each other by pins.

286. The eye-implantable retinal electrode array according to claim 283, wherein said epiretinal electrode and said subretinal electrode are held in a prescribed relationship to each other by snap-together mating parts.

287. A visual prosthesis comprising:
an electrode array body;

a plurality of electrodes disposed on said array body in at least two dimensions; and
a control unit activating said electrodes in multipolar patterns of stimulation, including more than two electrodes.

288. The visual prosthesis according to claim 287, wherein said control unit activates said plurality of electrodes in an electric field focusing arrangement.

289. An implantable electrode array for neural stimulation comprising:
an electrode array body;
a plurality of electrodes; and
a control unit activating said plurality of electrodes in a plurality of groups.

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290. A method of stimulating visual neurons comprising:
placing a plurality of electrodes against neural tissue in at least two dimensions; and
activating said electrodes in multipolar patterns of stimulation, including more than two electrodes.

291. The method according to claim 290, further comprising activating said electrodes in a field focusing arrangement.

292. The method according to claim 290, further comprising activating said electrodes in a plurality of groups.

293. An implantable device comprising:
an implantable device body;
a metallic pad on said implantable device body;
a biocompatible electrically conductive thin film covering said metallic pad; and
insulation deposited on said electrically conductive thin film.

294. The implantable device according to claim 293, wherein said implantable device includes an integrated circuit.

295. The implantable device according to claim 293, further comprising an adhesion ring deposited on said biocompatible electrically conductive thin film.

296. The implantable device according to claim 295, wherein said adhesion ring is deposited by ion-beam assisted deposition.

297. The implantable device according to claim 296, wherein said adhesion ring is titanium.

298. The implantable device according to claim 293, wherein said biocompatible electrically conductive thin film is deposited by ion-beam assisted deposition.

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299. The implantable device according to claim 298, wherein said biocompatible electrically conductive thin films forms at least a portion of a hermetic package.

300. The implantable device according to claim 293, wherein said biocompatible electrically conductive thin film is iridium oxide.

301. The implantable device according to claim 293, wherein said biocompatible electrically conductive thin film is Titanium Nitride.

302. The implantable device according to claim 293, wherein said biocompatible electrically conductive thin film is a group 8 metal.

303. The implantable device according to claim 293, wherein said insulation is deposited by ion-beam assisted deposition.

304. The implantable device according to claim 303, wherein said insulation forms at least part of a hermetic package.

305. The implantable device according to claim 293, wherein said insulation is a diamond coating.

306. The implantable device according to claim 303, wherein said insulation is aluminum oxide.

307. The implantable device according to claim 303, wherein said insulation is zirconium oxide.

308. The implantable device according to claim 303, wherein said insulation is selected from the group consisting of titanium oxide, tantalum oxide and aluminum nitride.

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309. The implantable device according to claim 293, wherein said biocompatible electrically conductive thin film is attached to said metallic pad by conductive glue.

310. An implantable electrode array comprising:
an electrode array body; and
a plurality of electrodes, on said electrode array body, having different lengths.

311. The implantable electrode array according to claim 310, wherein said electrode array body is generally flat.

312. The implantable electrode array according to claim 311, wherein said electrode array body includes an integrated circuit.

313. The implantable electrode array according to claim 310, wherein said plurality of electrodes are spike shaped.

314. The implantable electrode array according to claim 310, wherein tips of said plurality of electrodes lie on a curve in more than one direction.

315. The implantable electrode array according to claim 314, wherein tips of said plurality of electrodes lie on a three dimensional curve.

316. An implantable electrode array comprising:
an electrode array body;
a plurality of elongated electrodes; and
insulation deposited on portions of said plurality of elongated electrodes by ion-beam assisted deposition.

317. The implantable electrode array according to claim 316, wherein said plurality of elongated electrodes are adapted to stimulate visual neurons.

318. A visual prosthesis comprising:
a video receiver for receiving a video image and converting said video image to an electrical signal;
a video processing unit, coupled to said video receiver and processing said electrical signal;
an external communication unit, coupled to said video processing unit, transmitting said electrical signal;
an internal communication unit implanted in a living body receiving said electrical signal;
a plurality of electrodes driven by said internal communication unit and implanted subretinally, stimulating a retina to create a perception of said video image.

319. The visual prosthesis according to claim 318, wherein at least a portion of said internal communications unit is implanted in an eye, distant from said plurality of electrodes.

320. The visual prosthesis according to claim 318, wherein at least a portion of said internal communications unit is implanted outside an eye, but within a living body.

321. The visual prosthesis according to claim 318, wherein at least a portion of said internal communications unit is implanted subretinally.

322. The visual prosthesis according to claim 318, wherein at least a portion of said internal communications unit is implanted under a choroid.

323. A visual prosthesis comprising:
an external unit outside a living body providing power;
an internal unit within the living body receiving said power; and
a subretinal electrode array powered by said internal unit.

324. The visual prosthesis according to claim 323, wherein said power is inductive power.

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325. A visual prosthesis comprising:
an electrode array implanted within an eye and in contact with a retina; and
an electronic device implanted within a body and behind the eye communicating with said electrode array.

326. The visual prosthesis according to claim 325, wherein said electrode array is implanted subretinally.

327. The visual prosthesis according to claim 325, wherein said electrode array is implanted epiretinally.

328. The visual prosthesis according to claim 325, wherein said electrode array is electrically coupled to said electronic device.

329. The visual prosthesis according to claim 328, wherein said electronic device drives said plurality of electrodes.

330. The visual prosthesis according to claim 328, wherein said electrode array pierces the sclera.

331. The visual prosthesis according to claim 330, wherein said electrodes are elongated spike electrodes.